PCT/AU99/00263

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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 2908 for a patent by GLENBORDEN PTY LTD. and SUNICOVE PTY LTD., filed on 9 April 1998.

PRIORITY DOCUMENT

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day of May 1999

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

AUSTRALIA

Patents Act 1990

ORIGINAL

PROVISIONAL SPECIFICATION

2 PART REGULATOR

The invention is described in the following statement:

2 PART REGULATOR

FIELD

The present invention relates to a fluid regulator, the control of pressure and/or fluid flow, and/or rate of flow and/or parts therefore. The present invention has particular but not exclusive application to aerosols, trigger pumps, their actuators and/or nozzles and other fluid delivery mechanisms and/or containers.

CROSS REFERENCE

Reference is made to co-pending applications entitled Fluid Regulator for an Aerosol, Fluid Regulator for a Trigger Pump, and Diaphragm Regulator, filed on the same day by the present applicant, and hereinafter referred to respectively as Aerosol Application, Trigger Pump Application and Diaphragm Application. The disclosure of these applications is incorporated herein by reference.

BACKGROUND

Pressure regulators can be used in the regulation of the outlet pressure and/or fluid flow from such devices as aerosol containers. An example of this type of regulator is disclosed in UK patent 2216634, titled Pressure Regulators.

Pressure regulators of this type typically incorporate a number of parts in a housing, such as a spring, a diaphragm, and a valve adjacent an outlet opening. Normally the valve is connected to the diaphragm, such that movement of the diaphragm, as modified by the spring, controls the flow of fluid through the valve in a self regulating fashion.

The abovementioned types of regulators may be used with aerosol containers, which are produced in very large numbers. It is therefore desirable to have the simplest and least expensive pressure regulator for controlling the output flow of fluid from the aerosol, or any other container.

Pressure regulators, such as those disclosed in the aforementioned patent, contain numerous parts. The parts are made of different materials, such as metal for the spring, plastic for the piston and rubber for the diaphragm and seals. Assembly of these parts is therefore difficult as there may be four or more parts, all of which are typically very small. Further, as the parts must fit with each

other, the tolerances required in the manufacture of the parts become more critical as the number of parts increase. This is an important factor when parts must be assembled in large numbers, into a spray cap or housing for an aerosol container which is typically less than 20 mm in height and diameter. The components are relatively miniature and difficulty arises in handling and assembling them, particularly in a mass production environment.

In addition, these parts are designed to move with respect to each other and in response to pressure changes. Accordingly, parts whose dimensions fall outside the allowable tolerances cause the regulator to malfunction and not regulate the outlet pressure or fluid flow as would be desirable. As the number of parts increases, the tolerances of each part must decrease. For example, if a valve must fit into a port to restrict fluid flow, the tolerance of manufacture of the valve must be added to the tolerance of manufacture of the port in order to obtain a total tolerance for the valve assembly. If this total tolerance is excessive, the valve assembly will not function correctly. This has found to be particularly important when balanced regulators, or regulators having two valves and two corresponding ports, are used. A bent spindle or just one of the valves not sealing with its respective port will severely reduce the ability of the regulator to function adequately.

SUMMARY OF THE INVENTION

The present invention has as an object to alleviate at least one disadvantage associated with the prior art. A further object of the present invention is to provide a fluid regulation device that is of reduced size, while having tolerances that can be achieved using known mass production techniques.

Another object of the present invention is to provide a relatively inexpensive means of regulating the flow of fluid having a variable pressure.

In one form, the present invention relates to a fluid regulator including a diaphragm having an outlet aperture therein. This invention is based on the integration of a number of functions required in a regulated fluid delivery mechanism and allows the number of parts to be reduced and/or the overall dimensions of the regulator to be reduced. Preferably, the use of the spring

diaphragm as disclosed in the co-pending Diaphragm Application lends to the adoption of the present invention.

In another form, the present invention relates to a fluid regulator having a diaphragm, an outlet and a pressure chamber, wherein the diaphragm is situated on outlet side of the pressure chamber. Preferably, the outlet is within the diaphragm. This provides the advantage that the diaphragm regulates the pressure with respect to atmospheric pressure, while only requiring one aperture in the housing opening to the atmosphere. This reduces the number of parts of the regulator, and assists in the prevention of leaks. Further, if the diaphragm was situated distal from the outlet, the apparatus would be longer than necessary.

More preferably, the diaphragm is not sealed or enclosed. Accordingly, the number of parts is reduced, the diaphragm is, at least, partially open to the atmosphere, and the housing may be made smaller. Further, as the diaphragm incorporates the outlet aperture, a cover may be unnecessary. The diaphragm of the fluid regulator described above, having an aperture, is preferably situated downstream from the valve.

Further, the present invention relates to a regulator for controlling flow of a fluid, consisting of a housing having an inlet and a diaphragm having an outlet, wherein a portion of the diaphragm and a portion of the housing form between them a pressure chamber, and fluid flows into the pressure chamber through the inlet of the housing and out of the pressure chamber through the outlet in the diaphragm. This arrangement allows for a compact fluid regulator with relatively few parts.

The diaphragm may be operatively coupled to a valve which serves to regulate flow.

In another form, the present invention provides in combination, a spring diaphragm having an outlet therein and an aerosol or trigger pump as disclosed in co-pending applications discussed herein.

In another form, the present invention provides a three part fluid regulator, comprising a spring diaphragm, a valve and a housing (actuator).

In another form, the present invention provides a two part fluid regulator

comprising a spring diaphragm including an outlet aperture and a port portion of valve means, and a housing including a body member defining a portion of an actuator and an integral spindle.

In another form, the present invention provides a two part fluid regulator comprising a spring diaphragm including an outlet aperture and an integral spindle, and a housing including a body member defining a portion of an actuator and a port portion of valve means.

In another form, the present invention provides a method of assembling an actuator, including connecting a spring diaphragm and a housing (actuator) together.

The present invention also includes a fluid regulator including a spring diaphragm having an outlet aperture therein. The use of a spring diaphragm reduces the number of parts and allows the component parts of the regulator to be made of the same material, such as a plastics material. Spring diaphragms also have the advantage that they have a spring rate which increases with deflection, thus reducing the instability of the fluid regulator at start up.

Preferably the outlet apertures described above contain a nozzle. This allows the diaphragm and outlet to be inserted into a housing as a unitary part, making assembly much simpler. Further, the assembly formed from such as arrangement is smaller, allowing the housing to be smaller, without the disadvantage that smaller parts are harder to assemble.

In the present application the term fluid regulator is defined to mean an apparatus for the regulation or control of fluid flow, the flow rate and/or the pressure.

PREFERRED EMBODIMENT

One of the preferred embodiments of the present invention will now be described with reference to the accompanying diagrams, wherein:

Figure 1 is a sectional side view of a fluid regulator of the present invention;

Figures 2a-2c are isometric views of the pressure regulator shown in figure 1;

Figure 3a is a sectional view taken along line B-B of the diaphragm and

nozzle assembly of the fluid regulator shown in figure 3b;

Figure 3b is an end view of the regulator shown in figure 1;

Figures 3c and 3d are isometric views of views of the diaphragm and nozzle assembly of the fluid regulator shown in figure 1;

Figure 4 is a sectional side view of a second embodiment of the fluid regulator of the present invention;

Figure 5 is a sectional side view of a third embodiment of the fluid regulator of the present invention.

The disclosure made herein is in respect of a single faced regulator, but the present invention has equal application in conjunction with other regulators, such as balanced regulators as disclosed in the Aerosol Application and Trigger Pump Application.

It is desirable to regulate the outlet pressure of, for example, an aerosol container in order to obtain consistent results in terms of flow rate or outlet pressure. This is particularly important for containers of pressurised gases such as air or nitrogen. Existing aerosol containers normally contain a propellant such as hydrocarbon, which liquefies at moderate pressure. This type of propellant provides a relatively constant internal pressure inside the container as the product is expelled and the propellant evaporates, however hydrocarbons are not desirable as propellants for many reasons. Accordingly, a preferred embodiment of a pressure regulator in accordance with the present invention is described below.

A fluid regulator 10 is shown in fig 1. The regulator 10 includes a housing 12, an inlet 14, an outlet 16, a pressure chamber 18 and a diaphragm 20. The diaphragm 20 is connected to a valve assembly 26 by a spindle 28. The valve assembly 26 includes a valve 30 in a port 32. The spindle 28 is supported in the port 32 by a number of guides 38. In the illustrated example there are four guides 38 distributed around the periphery of the spindle 28, which is typically cylindrical in shape, as shown in the cross section taken through the spindle 28 at section A-A. The guides 38 reduce the friction of the spindle 28 in the port 32, and also allow the free passage of fluid between the spindle 28 and the port 32, while supporting the spindle 28 in position.

In figures 3a-3d, various views of the diaphragm 20 and spindle 28 are shown. The spindle 28 is integral with the diaphragm 20, as can be seen in figure 3d. Holes 44 in the diaphragm 20 provide a fluid passage connecting aperture 40 to the pressure chamber 18, thus allowing fluid to flow from the pressure chamber 18 to the outlet 16 and through nozzle 34. In the cross section of the diaphragm 20, spindle 28 and nozzle 34 taken along line B-B of figure 3b, the nozzle 34 can be seen in the aperture 40. In the embodiment shown in figure 1, the nozzle 34 at the outlet 16 occupies a large proportion of the aperture 40. A projection 46 provides an appropriate gap between the nozzle 34 and the diaphragm 20, allowing fluid to flow from the holes 44 into the aperture 40 and out the outlet 16 through nozzle 34. The nozzle 34 may be made integral with the diaphragm if desired, or the holes 44 could be used to function as nozzles, depending on the fluid to be regulated and the application to which the fluid is put. The holes 44 could also form part or all of the aperture 40. There is no necessity for the regulator 10 to include a nozzle.

The diaphragm itself may be made from a material that allows the flow of the fluid from one side to the other, but also has sufficient resistance to flow in relation to stiffness to cause the diaphragm to move as fluid flows through it in order to effectively actuate the flow control valve.

The diaphragm 20 may be attached in a substantially sealing manner to the housing 12 by ultrasonic welding, gluing, an interference fit or other appropriate method.

The diaphragm 20 also includes a number of weakened portions in the form of one or more circumferential grooves 42. These allow the central portion of the diaphragm 20 to pivot around the grooves 42 so that spindle 28 moves laterally the appropriate amount relative to the port 32. The working of the diaphragm is explained in the co-pending Diaphragm Application, where other methods of providing a diaphragm with weakened portions are also discussed.

In use, with reference to the embodiments shown in figures 1 and 3a-3d, an actuating surface 36 on the housing 12 is pressed downwardly, causing fluid to flow up out of the aerosol container 22, past the stem gasket 43, through the stem 24 and into the inlet 14. At the start of operation, the pressure in the

chamber 18 will be atmospheric, and therefore the diaphragm 20 will be in a free position, that is, not subject to external stresses from fluid pressure. When the diaphragm 20 is in the free position, the spindle 28 connecting the diaphragm 20 to the valve 30 places the valve in an open position, allowing free fluid communication between the inlet 14 and the pressure chamber 18, through the port 32. As fluid flows into the pressure chamber 18, the pressure increases and causes the diaphragm 20 to move in a direction away from the port 32. This causes the connected valve 30 to move towards the port 32 reducing the gap between the port 32 and the valve 30. If the pressure in the pressure chamber 18 increases significantly, the valve will move to be closer to the port 32, thus substantially sealing the inlet 14 from the pressure chamber 18.

Simultaneous to the fluid flowing into the pressure chamber 18, the fluid also flows in a partially restricted manner through one or more holes 44 in diaphragm 20 and into aperture 40. Typically, a nozzle 34 is situated in the aperture 40 at the outlet 16, and fluid flows out of nozzle 34, causing the fluid to disperse, for example, into fine droplets. The pressure in the pressure chamber 18 is dependant on the relative flow rate of the fluid into the pressure chamber 18 past valve 30 and through port 32, compared to the flow rate of the fluid out of the pressure chamber 18 through holes 44 into aperture 40 and out outlet 16 through nozzle 34. As fluid flows through aperture 40 to outlet 16, the fluid flow is further restricted through the nozzle 34, and there may also be a number of small channels which cause the fluid to flow in a spiral pattern before passing through the nozzle, in order to assist in the break up of the particles. The level of restriction required depends, among other things, on the viscosity of the fluid and the size of the holes 44 and nozzle 34.

The pressure in the pressure chamber 18 determines the position of the valve 30, and therefore the higher the pressure in the chamber 18 the closer the valve 30 is to the port 32. After a short period of operation, an equilibrium is established, wherein the pressure in the chamber 18 and therefore the outlet pressure or flow rate of the fluid, can be regulated to a particular level, within approximately +/-10%. The pressure level or flow rate can be varied according to the stiffness or spring rate of the diaphragm 20 and the flow resistance of the

fluid from pressure chamber 18 through nozzle 34 and outlet 16. The spring rate of the diaphragm 20 may be set at the time of manufacture by, for example, the size and number of the grooves 42 or by varying the thickness of diaphragm 20. Once equilibrium is established the position of the valve 30 relative to the port 32 stays substantially constant. This equilibrium state causes the flow of fluid from the nozzle 34 to be substantially constant over a range of pressures in the aerosol container 22.

The nozzle 34 may incorporate a number of apertures of various sizes depending on the flow rate required, the types of operating pressures, and the type of fluid to be dispensed.

In the embodiment shown in figures 1 and 3a-3d, the diaphragm 20 is manufactured integrally with the spindle 28. The integral diaphragm and spindle assembly may be made from a plastics material, for example, a plastics material having resilient properties and having good resistance to creep.

It has been discovered that trigger pumps and aerosols are usually only activated in short bursts, and accordingly, the diaphragm 20 is subject to pressure from the pressure chamber 18 for only short periods of time. Therefore, a plastics material is adequate for the purpose of the diaphragm 20. The spindle 28 is required to have a stiffness sufficient for the valve 30, at the end distal from the diaphragm 20, to be inserted through the port 32, which is of slightly smaller diameter than the valve 30, in order to effect at least a partial seal. Since regulator 10 is not intended to be disassembled, the spindle only has to be sufficiently stiff to withstand pushing the valve 30 through the port 32 once, even if regulator 10 is removed and placed on another container. Further, where the diaphragm and spindle are integral and the nozzle is separate, the flow rate from the regulator can be varied by simply changing nozzles.

The diaphragm and spindle assembly of the present invention may be injection moulded for mass production, either integrally or individually. If the diaphragm and spindle assembly are manufactured separately, the spindle may be attached to the diaphragm by an interference fit, for example, a spindle having a fluted end to be received into an aperture in the diaphragm (not shown). The flutes would allow fluid to travel between the spindle and

diaphragm and out of the nozzle.

Alternatively, the spindle 28 and diaphragm 20 are integral as shown in figures 1 and 3a-3d, and the nozzle 34 is inserted into the diaphragm 20 at the aperture 40. Aperture 40 may include a number of number of smaller apertures which allow the fluid to pass therethrough, to the nozzle 34.

In an alternative embodiment shown in figure 4, the spindle 28 may be made integral with the housing 12. A channel 45 connects the inlet 14 to a valve chamber 46. The valve chamber 46 regulates the pressure entering the pressure chamber 18, as the fluid must flow through port 32 in aperture 40. The fluid flow through port 32 is regulated by the movement of the diaphragm 20, relative to the valve 30 on the spindle 28. Increased pressure in the pressure chamber 18 causes the port 32 in the aperture 40, via the diaphragm 20 to move towards the valve 30, thus reducing the flow of fluid entering the pressure chamber 18.

A further embodiment is shown in figure 5 wherein the regulator 10 has the spindle 28 integral with the housing 12. The fluid flows from inlet 14 through a passage 45 into the pressure chamber 18 where it causes the diaphragm to move relative to the spindle 28. A valve 27 in the diaphragm 18 moves relative to the valve 30 on the spindle, thus controlling the flow of fluid flowing therebetween. In this way, fluid is restricted from flowing into the aperture 40 where it exits through outlet 16.

In the embodiments shown in figures 4 and 5 the use of the aperture in the diaphragm and the spindle attached tot he housing allows the diaphragm to be lighter and therefore more responsive to changes in pressure during operation. The most significant change in pressure occurs during the initial opening of the valve in the aerosol container, where pressures rise from atmospheric to several atmospheres very quickly. The attachment of the spindle to the housing reducing the mass of the diaphragm required to move in response to the pressure changes, and therefore the response time is reduced. Further, as the mass of the diaphragm is reduced, but the damping forces in the diaphragm are the same, there is an increase in the overall damping of the diaphragm movement, which reduces hunting.

In all the embodiments shown in figures 1, 3a-3d, 4 and 5, the resilient properties of the diaphragm widen the gap between the ports and the valves as pressure in the pressure chamber decreases. This is achieved using a diaphragm made from a plastics material as the flow of fluid through an aerosol is typically only in short bursts. Therefore a metal spring is not necessary. A plastics material that has good resistance to creep is normally chosen in the construction of the diaphragm, and this is sufficient to prevent creep becoming a factor in the performance of the diaphragm over its short use period. The long periods of inaction typical in aerosol containers enable any initial displacement due to creep to reduce.

A sealing arrangement may be incorporated into the pressure chamber 18, for example, in the embodiment shown in figure 1. This sealing arrangement (not shown) may include any suitable o-ring which seals, for example, with a built up portion on the housing proximate the spindle. In operation, fluid may then flow into the pressure chamber 18, but not through holes 44 and out outlet 16, until a predetermined pressure is achieved in the pressure chamber 18, wherein the diaphragm, and therefore the o-ring, will move away from the built up potion of the housing. Once the o-ring moves away from the built up face of the hosing, fluid may flow into holes 44 and out of outlet 16. In this way, fluid flow could be further regulated to within an upper and lower pressure limit.

Referring to the co-pending Diaphragm Application, the diaphragms described in the specification and shown in figures 3a-3h may be used with suitable modification for the outlet aperture, in the pressure regulator of the present invention.

Further, a balanced regulator, as shown in the Diaphragm Application, can be used in conjunction with the present invention. In the case of a balanced regulator being used, as, for example, with reference to the regulator shown in figure 1 of the aerosol application, the nozzle 10 can be removed and a blocked by a wall, and the diaphragm 201 could be modified as shown in the present application to accommodate a nozzle. The cover is also removed, thus reducing the number of parts and only requiring one aperture in the housing 12.

While specific arrangements of the diaphragm and aperture have been shown in figures 1, 3a-3d, 4 and 5, there are many different ways in which the aperture and diaphragm of the present invention can be arranged. For example, the aperture may extend all the way through the diaphragm, and the spindle may be attached to the diaphragm by a number of connecting elements;

Further, in the present invention, an aperture is defined to include, among other things:

- a means for allowing fluid to travel from one portion or side of the diaphragm to another portion or side;
- a fluted opening;
- an opening having an insert for directing the flow of fluid;
- a number of openings;
- a mesh covering part of the diaphragm, allowing the flow of fluid therethrough;
- a permeable membrane such that fluid may flow through at least some of the diaphragm;
- a recess.

In the present application, fluid is taken to mean any substance or material capable of flowing, and includes, gases, liquids, solid particles suspended in liquids and flowable solids such as granules suspended in a liquid or gas.

While the present invention has been discussed in relation to aerosol containers, the regulator could be used in any application where it is desired that a variable pressure or flow rate of fluid is controlled. Examples of such ons are water pipes or hoses, gas valves, trigger pumps (as discussed in detail in the trigger pump application) etc.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A fluid and/or pressure regulator including a diaphragm having an outlet aperture therein.

2. A fluid and/or pressure regulator having a diaphragm, an outlet and a pressure chamber, wherein the diaphragm is situated on the outlet side of the pressure chamber.

3. The regulator of claim 2 wherein the outlet is within the diaphragm.

4. The regulator of any one of the preceding claims wherein the diaphragm is situated downstream from a valve.

5. The regulator of claim 4 wherein the diaphragm is operatively coupled to the valve which restricts fluid flow through the inlet of the pressure chamber.

6. A fluid and/or pressure regulator including a diaphragm having an aperture therein through which fluid flows.

7. The regulator of claim 6 wherein a portion of the diaphragm forms part of a pressure chamber, and a portion of a housing with a valve forms another part of the pressure chamber, and the aperture moves relative to the valve to regulate the flow of fluid into the pressure chamber.

8. A regulator comprising a spring diaphragm, a valve and a housing.

9. The regulator of claim 8 wherein the spring diaphragm contains an aperture therein.

10. The regulator of claim 8 having a pressure chamber formed at least in part by the spring diaphragm, and the housing having the valve attached thereto, wherein changes in pressure in the pressure chamber cause the aperture in the spring diaphragm to move relative to the valve, thus regulating the flow of fluid into the pressure chamber.

11. The regulator of claim 8 wherein either of the housing or the diaphragm has an aperture, and the other of the housing or diaphragm has the valve.

12. The regulator of claims 7, 10 and 11 wherein fluid flows into the pressure chamber through an inlet of the housing and out of the pressure chamber through an outlet in the diaphragm.

13. The regulator of claim 12 wherein the spring diaphragm and outlet cooperate to provide regulation of fluid flow into and/or pressure inside of the pressure chamber.

14. In combination, a spring diaphragm having an outlet therein and an aerosol or trigger pump as disclosed in any one or all of co-pending applications Aerosol, Trigger Pump, Diaphragm.

15. A combination as claimed in claim 14, wherein the diaphragm serves to provide flow and/or pressure regulation.

16. A three part fluid regulator, comprising a spring diaphragm, a valve and a housing (actuator).

17. A regulator as claimed in claim 16, wherein an outlet aperture is provided in one of the housing, diaphragm or valve.

18. A two part fluid regulator comprising a spring diaphragm including an outlet aperture and a port portion of valve means, and a housing including a body member defining a portion of an actuator and an integral spindle.

19. A two part fluid regulator comprising a spring diaphragm including an outlet aperture and an integral spindle, and a housing including a body member defining a portion of an actuator and a port portion of valve means.

20. The regulator of any of the preceding claims wherein the outlet aperture contains a nozzle.

21. The regulator of any of the preceding claims whereby the diaphragm is made from a plastics material.

22. A pressure and/or fluid regulator as shown in figures 1, 3a-3d, 4 or 5.

23. The regulator of any one of the preceding claims wherein the spindle and diaphragm are integral.

24. The regulator of any one of the preceding claims wherein the spindle is integral with the housing.

25. The regulator of any of the preceding claims wherein the diaphragm is partially uncovered.

26. A method of assembling an actuator, including connecting a spring diaphragm and a housing (actuator) together.

DATED THIS 9th day of April, 1998

<u>GLENBORDEN PTY LTD and SUNICOVE PTY LTD</u>

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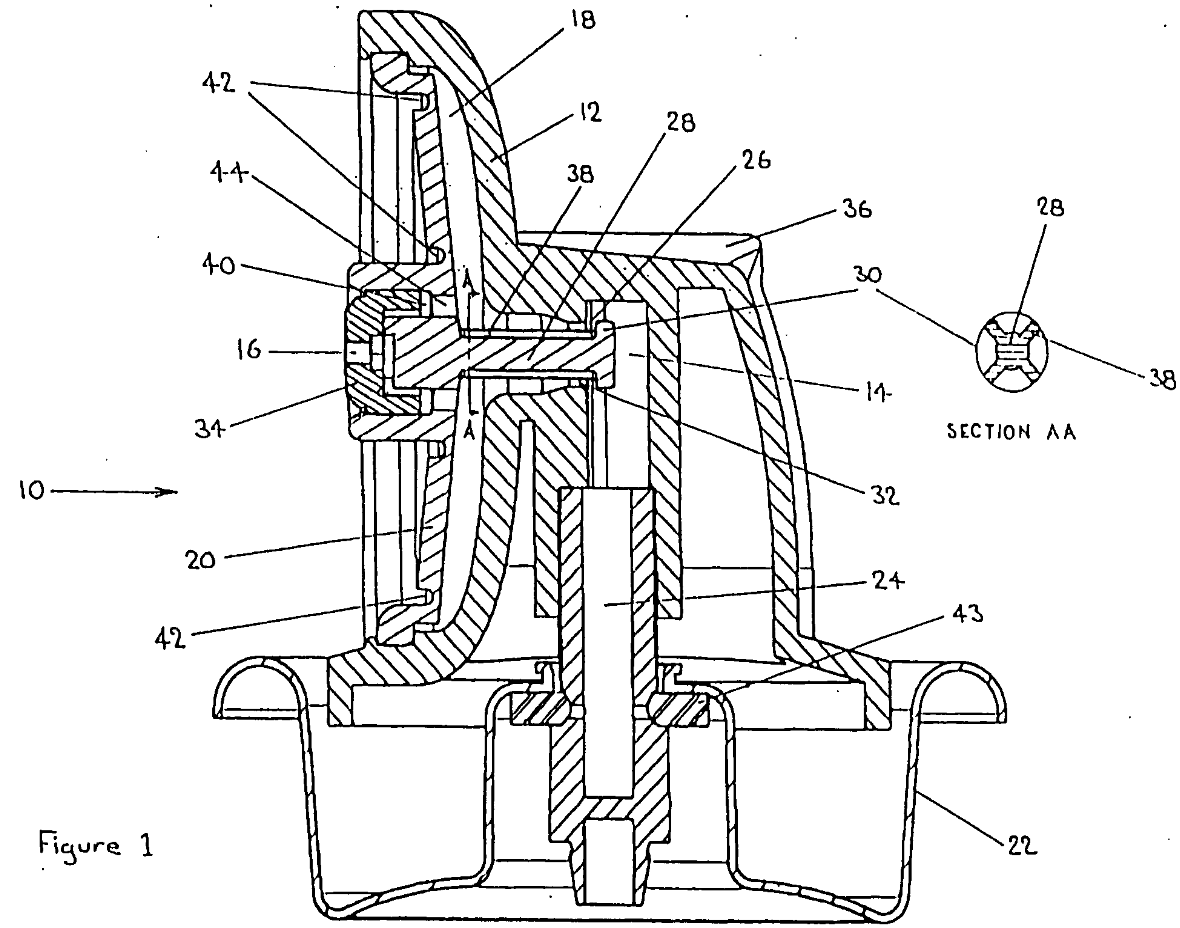

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SECTION AA
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Figure 1

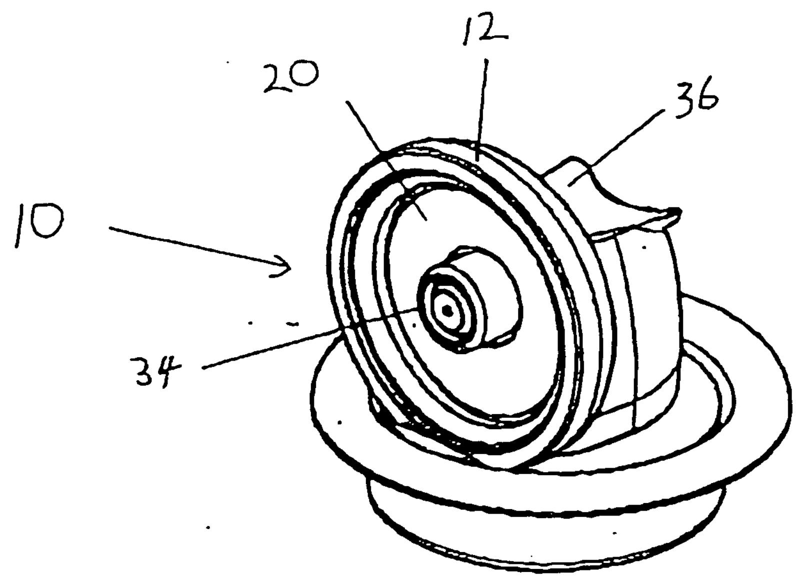


Figure 2a

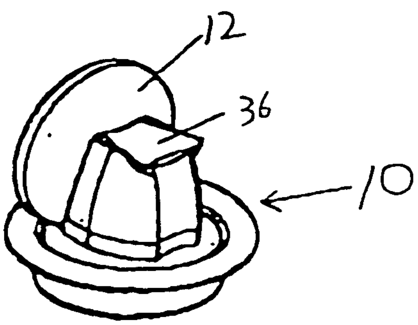


Figure 2b

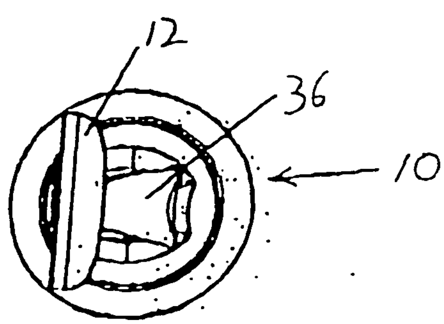


Figure 2c

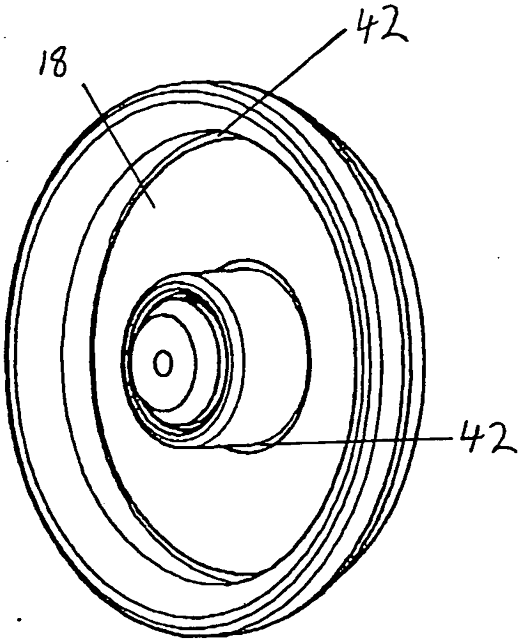


Figure 3c

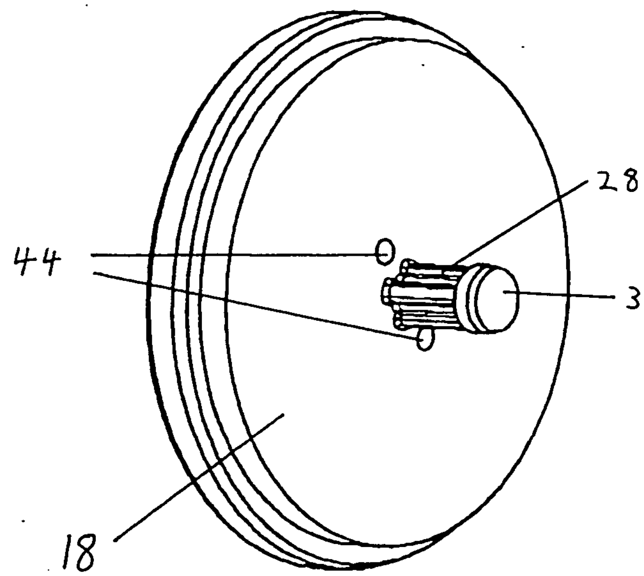
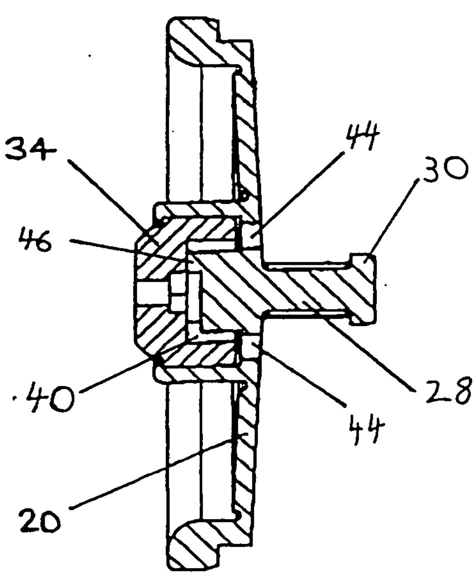


Figure 3d



SECTION BB

Figure 3a

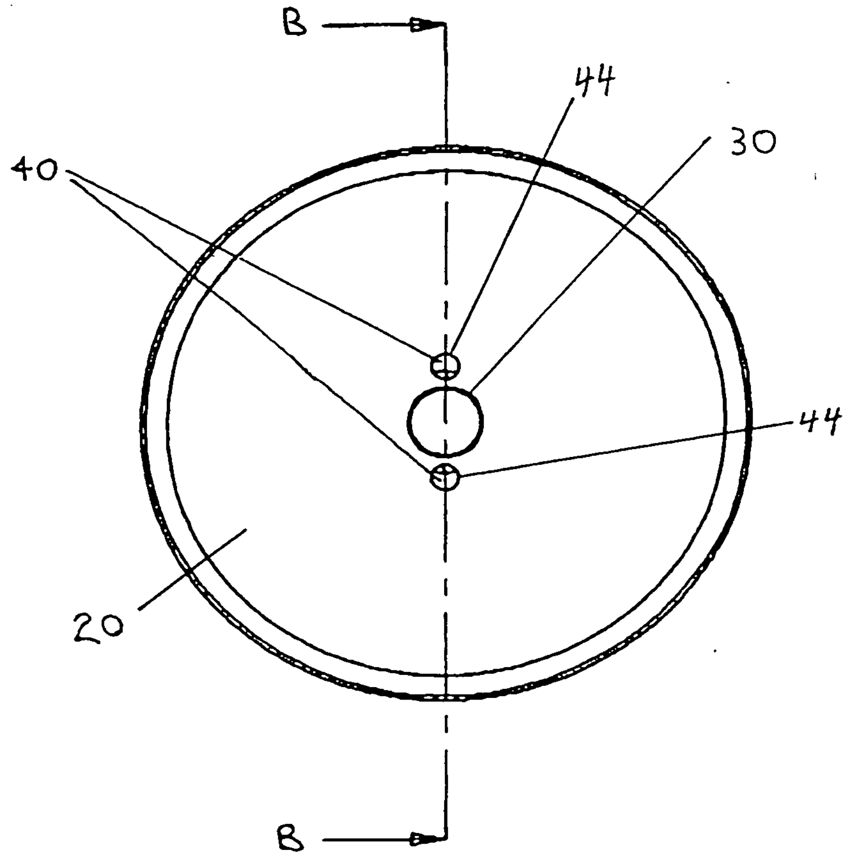


Figure 3b

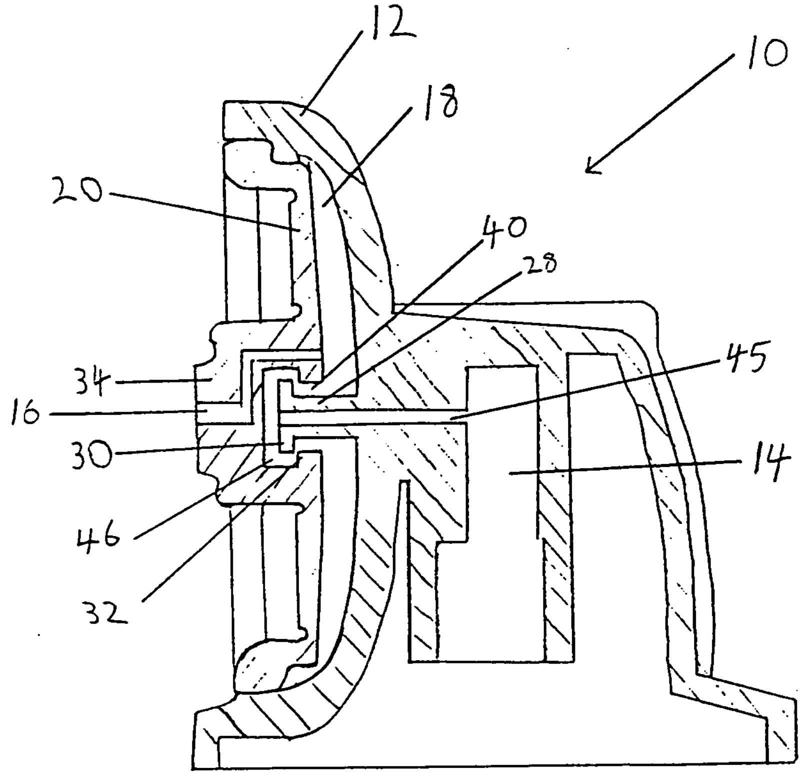


Figure 4

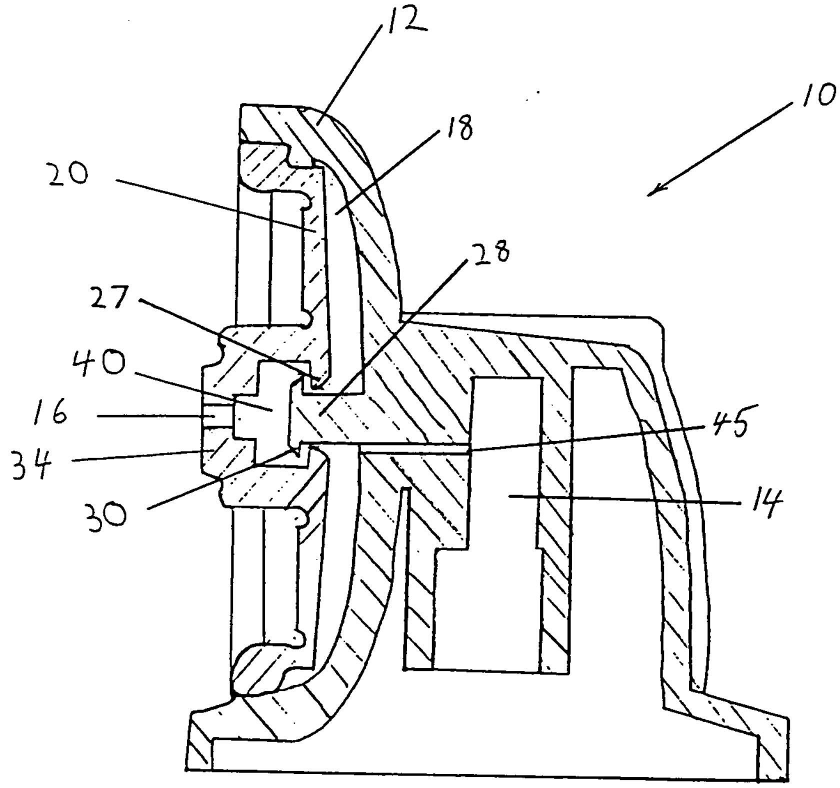


Figure 5

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